

What is claimed is:

1. A method for estimating a target specific spectral distribution on at least one target over a period of at least one time measurement in a sensor space having at least one spatial cell and at least one spectral cell comprising:

providing a spectral probability density function;

calculating the component spatial cell probabilities for each said time measurement, for each said target and for the total number of said spatial cells;

calculating the combined component spatial and spectral cell probabilities by taking the matrix outer product of said component spatial cell probabilities and said provided spectral probability density function for each said target;

summing said combined component spatial and spectral cell probabilities for all said targets to obtain a total combined spatial and spectral cell probability for all said targets;

summing said total combined spatial and spectral cell probabilities for all said targets over all spectral cells and all spatial cells to obtain a total sensor space probability;

calculating an expected sensor space measurement for all spectral cells and all spatial cells;

determining the relative mode contributions for all said targets using the combined component spatial and spectral cell probabilities and the total combined spatial and spectral cell probability for all said targets;

calculating the average spectral power on each said target using the relative mode contributions for all targets, the expected sensor space measurement for all spectral cells and spatial cells, the combined component spatial and spectral cell probabilities and the total combined spatial and spectral cell probability for all said targets over all time measurements;

linking all of the average spectral powers of all of the targets to obtain a spectral distribution estimate for each of the targets; and

displaying said spectral distribution estimates on a computer display screen for each said target.

2. A method for tracking at least one target over a period of at least one time measurement using batches of data obtained from sensors designed to detect energy signals from said target in a sensor space having at least one spatial cell and at least one spectral cell comprising:

initializing an estimated mixing proportion for each said target;

initializing an expected signal width of the energy signal of each said target;

initializing a process covariance matrix for each said target;

initializing a spectral estimate of the energy signal of
each said target;

providing a spectral probability density function;

calculating the component spatial cell probabilities for
each said time measurement, for each said target and
for the total number of said spatial cells using said
spatial state of said target and said estimated signal
width of said target;

calculating the combined component spatial and spectral
cell probabilities by taking the matrix outer product
of said component spatial cell probabilities and said
provided spectral probability density function for
each said target;

summing said combined component spatial and spectral cell
probabilities for all said targets to obtain a total
combined spatial and spectral cell probability for all
said targets;

summing said total combined spatial and spectral cell probabilities for all said targets over all spectral cells and all spatial cells to obtain a total sensor space probability;

calculating an expected sensor space measurement from said total combined spatial and spectral cell probability for all said targets and from said total sensor space probability, for all spectral cells and all spatial cells;

computing a spatial cell first order moment for all said targets for each spatial cell in said sensor space using the expected signal width of the energy signal of each said target and the spatial state of each said target;

determining the relative mode contributions over all time measurements for each target using all of the combined component spatial and spectral cell probabilities and the total combined spatial and spectral cell probabilities for all said targets;

calculating estimated mixing proportions for each target
using the relative mode contributions of each said
target;

formulating a synthetic spatial measurement based on the
expected sensor space measurement, the total combined
spatial and spectral cell probability for all targets,
the combined spatial and spectral cell probability for
each said target, and the relative mode contribution
of each said target;

formulating at least one synthetic covariance matrix for
said synthetic spatial measurement by taking a product
of the estimated mixing proportions and the relative
mode contributions for each said target and dividing
the product by the expected signal width of the energy
signal of the target;

formulating at least one synthetic process covariance
matrix based on said total sensor space probability;

calculating a spatial state for each said target through
the use of a recursive Kalman smoothing filter on the
synthetic spatial measurement, the synthetic

covariance matrix and the synthetic process covariance matrix of each said target;

computing a spatial cell second order moment for each said targets for each spatial cell in said sensor space using the expected signal width of the energy signal of each said target and the spatial state of each said target;

determining signal width estimates for each target using the spatial cell second order moments for each said target, the spectral estimate of the energy signal of each said target, the total combined spatial and spectral cell probability for all said targets the expected sensor space measurement for all spectral cells and all spatial cells, and relative mode contributions over all time measurements;

repeating the previous steps beginning with said step of calculating the component spatial cell probabilities, until there is a convergence in the spatial state for all said targets;

calculating the average spectral power on each said target using the relative mode contributions for all targets, the expected sensor space measurement for all spectral cells and spatial cells the combined component spatial and spectral cell probabilities and the total combined spatial and spectral cell probability for all said targets over all time measurements;

linking the average spectral power on all of the targets to obtain a spectral distribution estimate for each of the targets; and

displaying said spatial state, signal width estimate and spectral distribution estimate on a computer display screen for each said target.

3. A method according to claim 2 wherein the spectral distribution estimates, and the resulting spatial states serve as initialization points for the processing of a subsequent batch of sensor data.

4. A method according to claim 2 wherein the iterations of steps beginning with said step of calculating the component

spatial cell probabilities, is iterated for a predetermined minimum number of iterations.

5. A method according to claims 2 wherein said calculating the component spatial cell probabilities for each said time, for each said target and for the total number of said spatial cells further comprises:

$$P_{ki}^{(l)}(X_t) = \begin{cases} 1/U, & k = 0 \\ \int_{D_i} N(\tau; H_{tk}x_{tk}^{(l-1)}, R_{tk}^{(l-1)}) d\tau, & k \neq 0 \end{cases}$$

6. A method according to claim 2 wherein said computing a spatial cell first order moment for all said targets for each spatial cell in said sensor space further comprises:

$$\mu_{tki}^{(l)} = \int_{D_i} \tau N(\tau; H_{tk}x_{tk}^{(l-1)}, R_{tk}^{(l-1)}) d\tau.$$

7. A method according to claim 2 wherein said computing a spatial cell second order moment for each said targets for each spatial cell in said sensor space further comprises:

$$\sigma_{tki}^{(l)} = \int_{D_i} (\tau - H_{tk}x_{tk}^{(l-1)})^2 N(\tau; H_{tk}x_{tk}^{(l-1)}, R_{tk}^{(l-1)}) d\tau.$$